Reconfigurable Double Slot-Ring Antenna for Bandwidth Enhancement

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Abstract

A reconfigurable single slot-ring antenna is able to switch between S and C bands using PIN diode switches. However, the fractional bandwidth of this single slot-ring antenna at lower band is narrow (11.4%). In this work, four additional slots are added to form a double slot-ring antenna at the lower band. As a result, the antenna fractional bandwidth at the lower band is significantly enhanced from 11.4% to 28.2%, while the antenna performance at higher band is not compromised. Full-wave simulations show that the antenna efficiency is high and the radiation patterns do not change across each respective frequency band.

Index Terms: Broadband antenna; PIN diode switches; reconfigurable slot-ring antenna.

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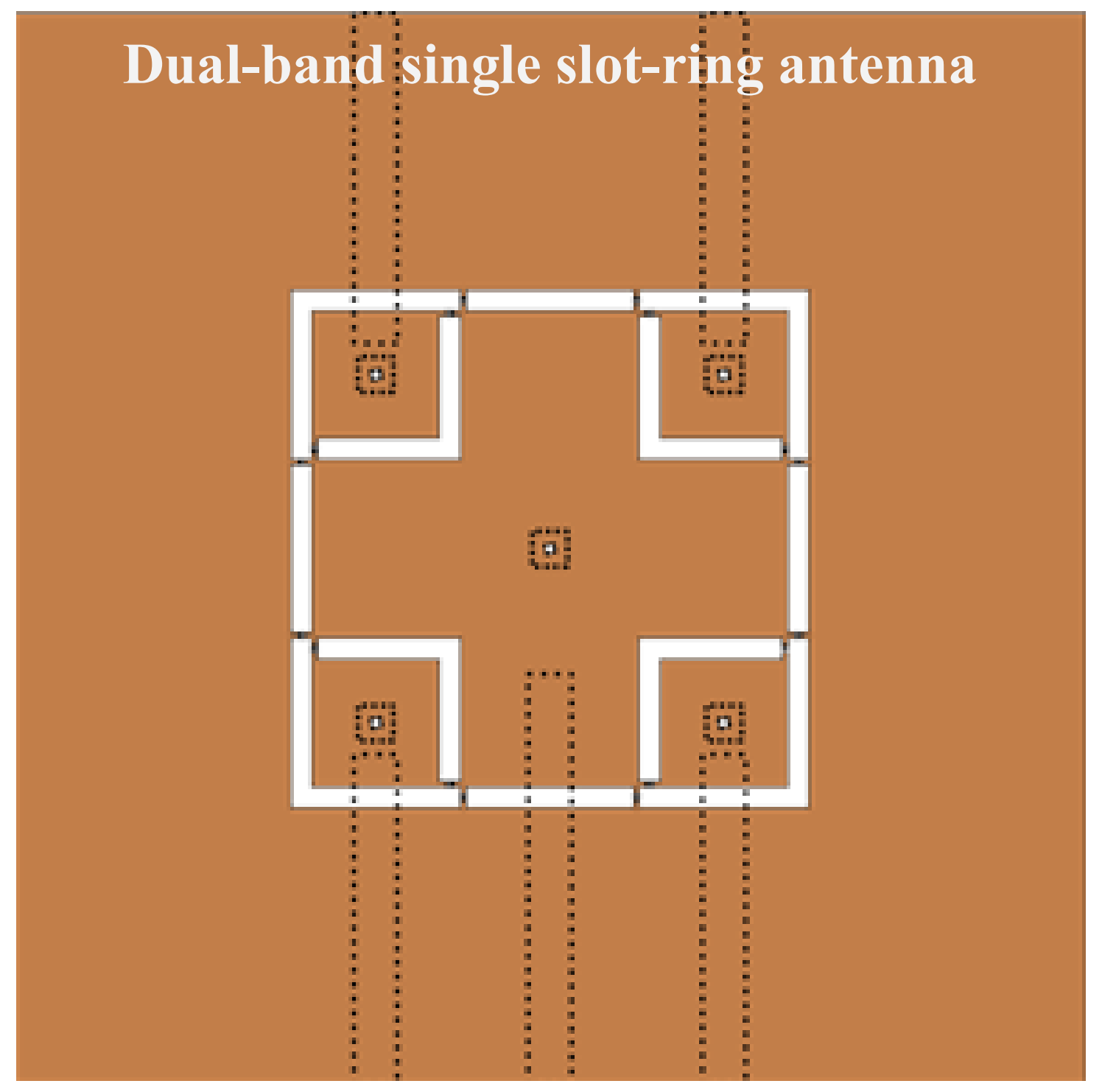
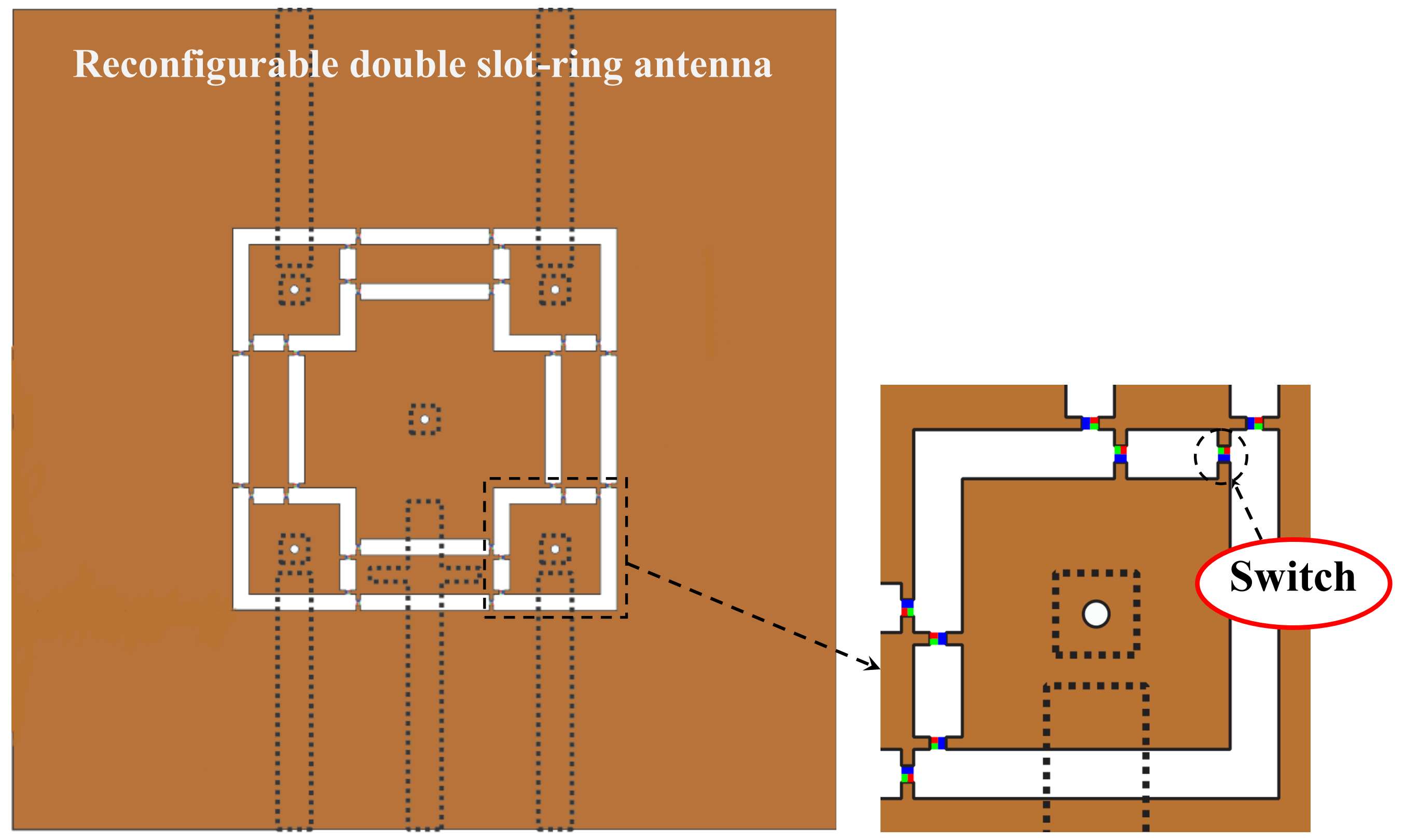
Introduction

- Wide-band planar slot antennas are realizable using wide-slot, fractal-shaped slot or substrate removal under the slot
- Reconfigurable slot antennas with PIN diodes, FETs or MEMS switches with narrow Fractional Bandwidth (FBW) have been demonstrated in the literatures
- Wide-band reconfigurable antenna using double slot-ring is proposed
- The antenna structure is extended from the dual-band single slot-ring antenna by adding four additional slots
- The PIN diode switches are used to switch between the frequency bands, similar to the single slot-ring antenna.



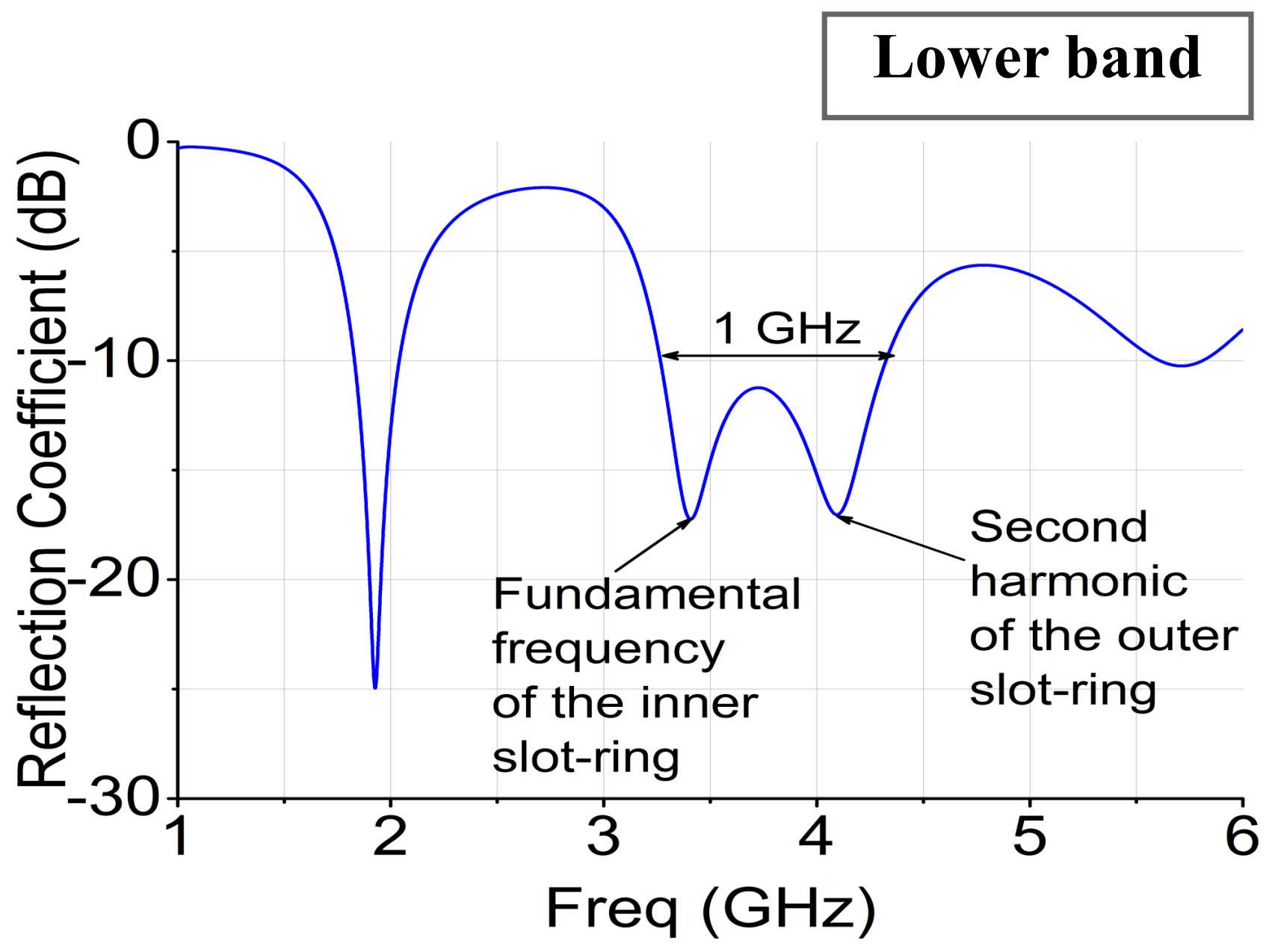
Dual-band single slot-ring antenna

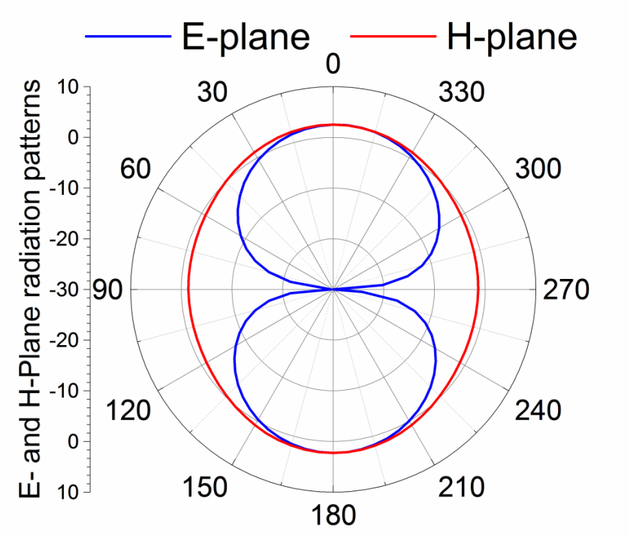


Reconfigurable double slot-ring antenna

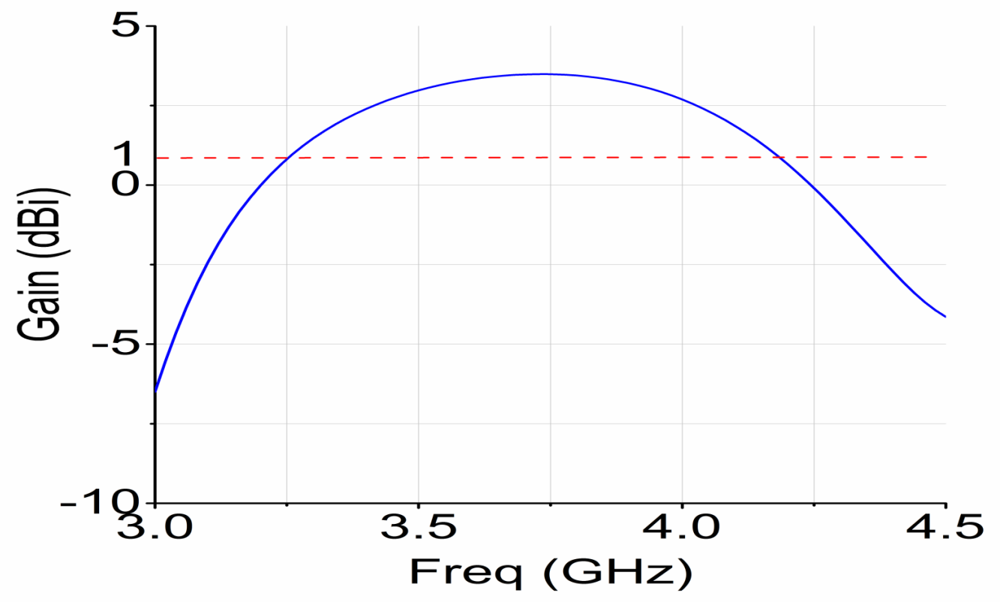
Bandwidth Enhancement at Lower band

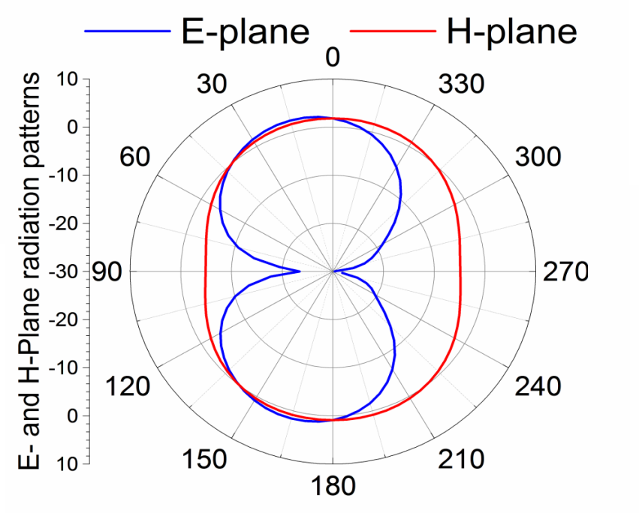
- It is known that the resonance frequency of the slot-ring is determined by its perimeter. Therefore, the inner ring has higher resonance frequency than the outer ring because it has shorter perimeter
- Fundamental frequency of the inner slot-ring and the second harmonic of the outer slot-ring merge into a wider bandwidth at lower band of operation
- By changing the state of PIN diode switches, 2×2 slot-ring antenna array is formed at higher band of operation



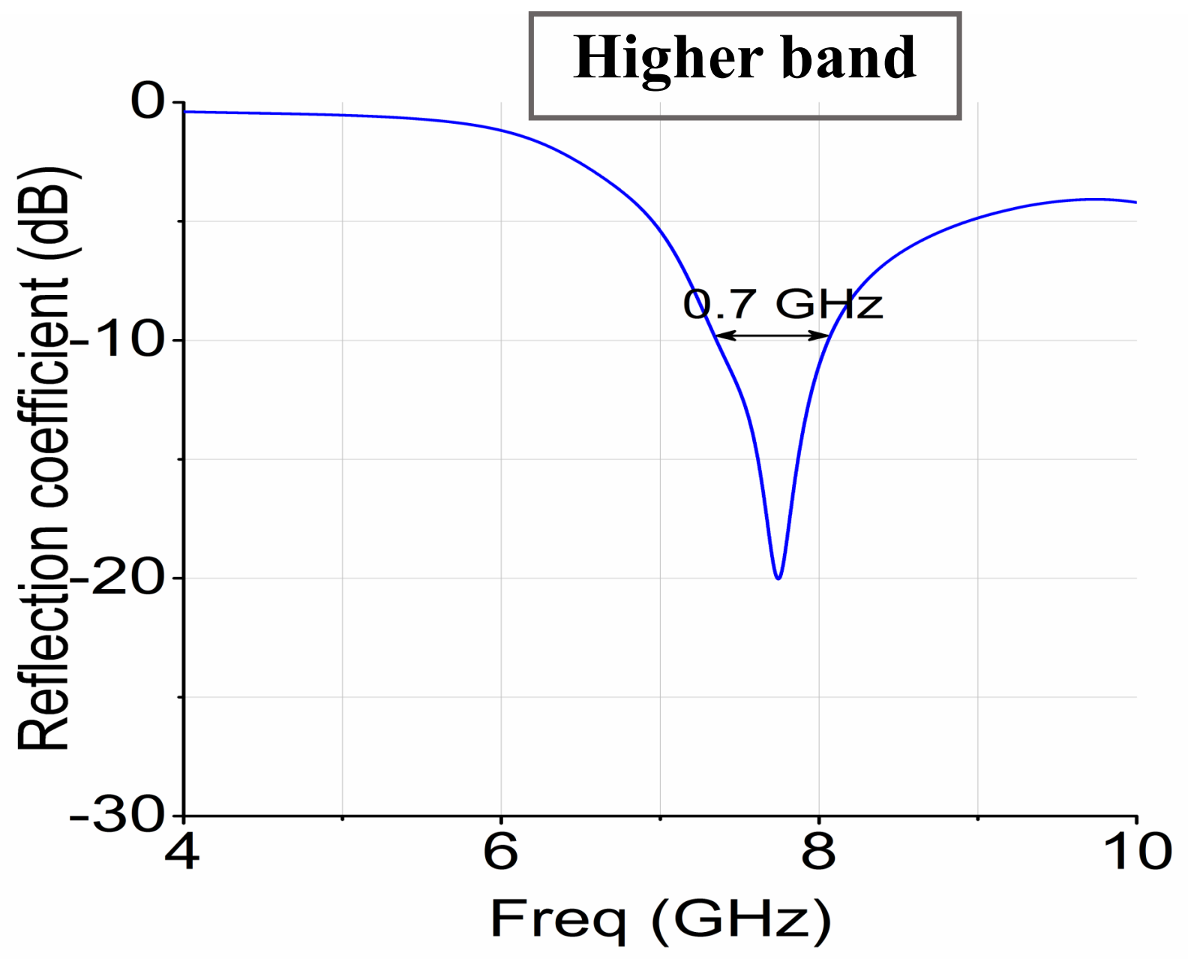


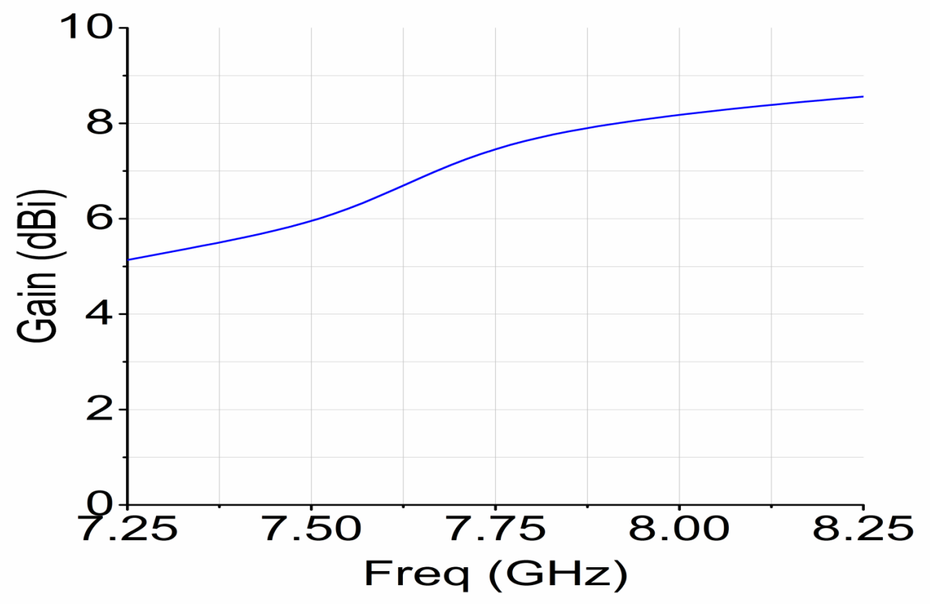
3.37 GHz

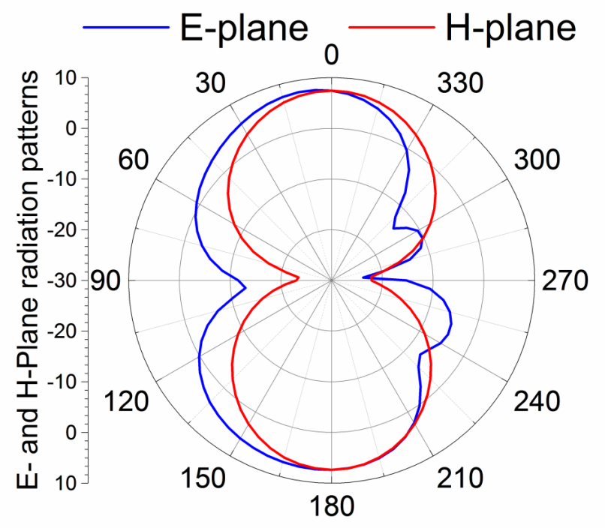




4.10 GHz







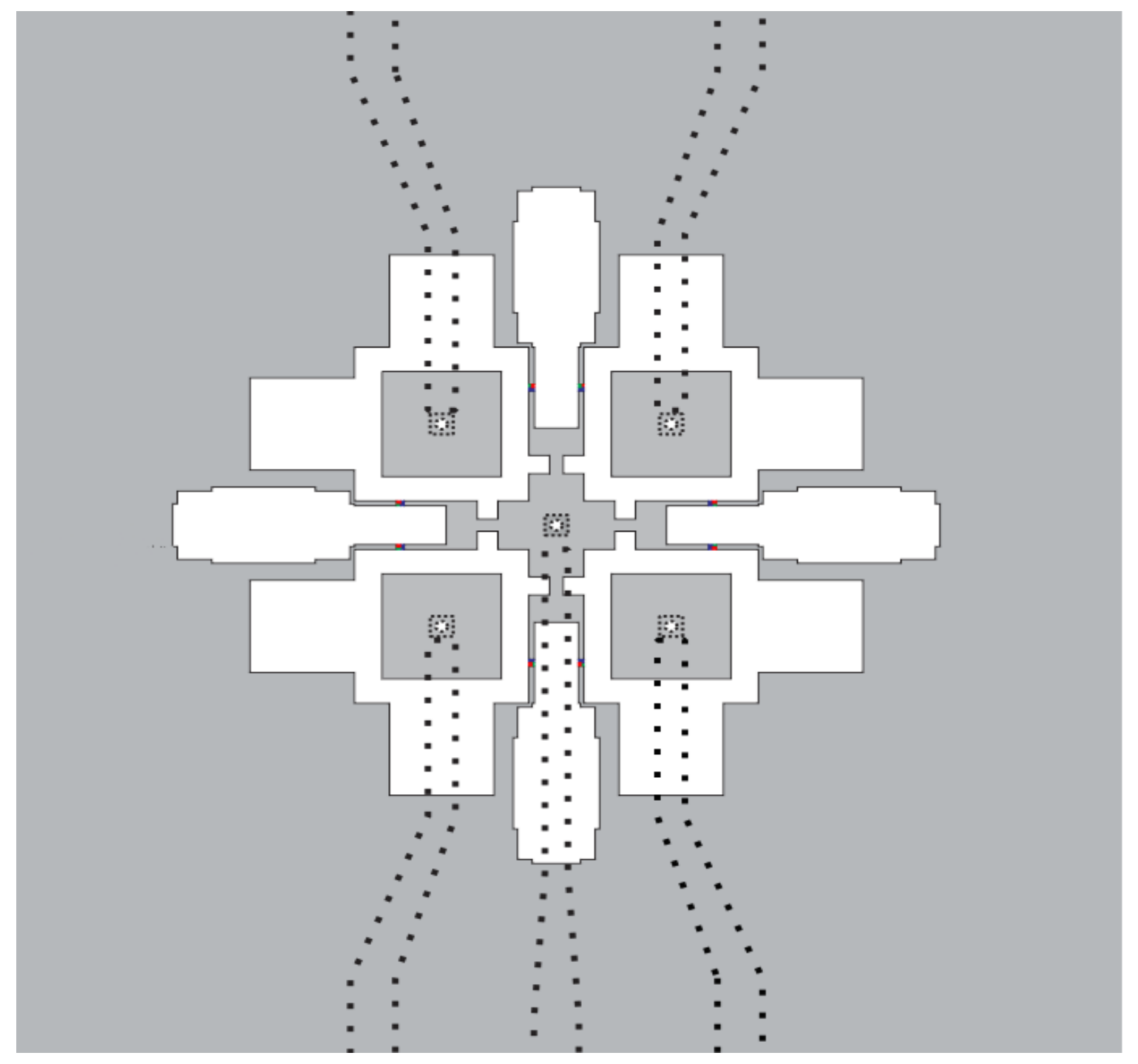
7.7 GHz

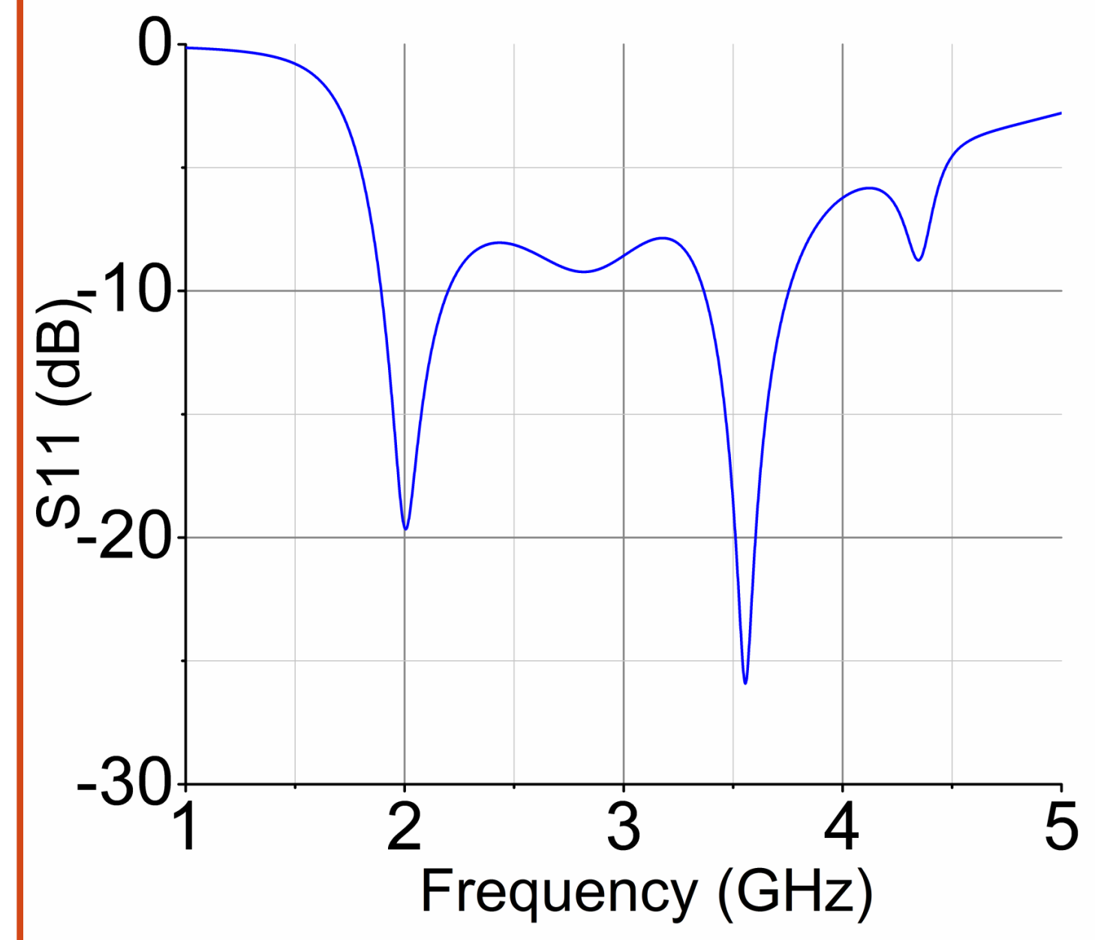
- Single slot-ring antenna is compared with the double slot-ring antenna in terms of center frequency, FBW, gain and radiation efficiency
- The number of switches in the double slot-ring antenna is increased from 16 to 32 for the four additional slots. The resistance within each switch contributes to the reduction of antenna efficiency

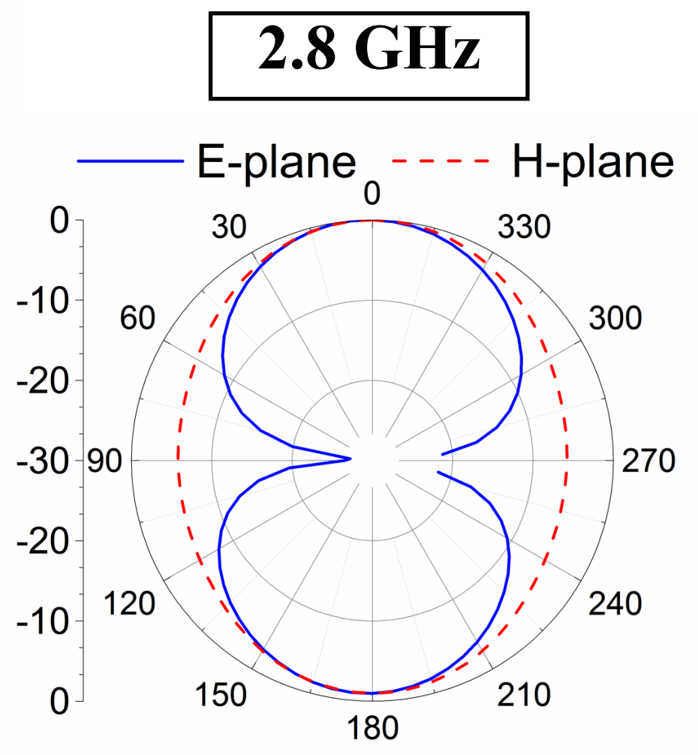
		f₀ (GHz)	*FBW (%)*	*G (dBi)*	*η (%)*
Lower band	Single slot-ring ant.	2.0	11.4	-1.5	93.0
	Double slot-ring ant.	3.4	28.2	1.8	80.0
Higher band	Single slot-ring ant.	8.0	10.3	6.2	92.4
	Double slot-ring ant.	7.7	9.1	6.1	80.5

Fractal-shaped antenna

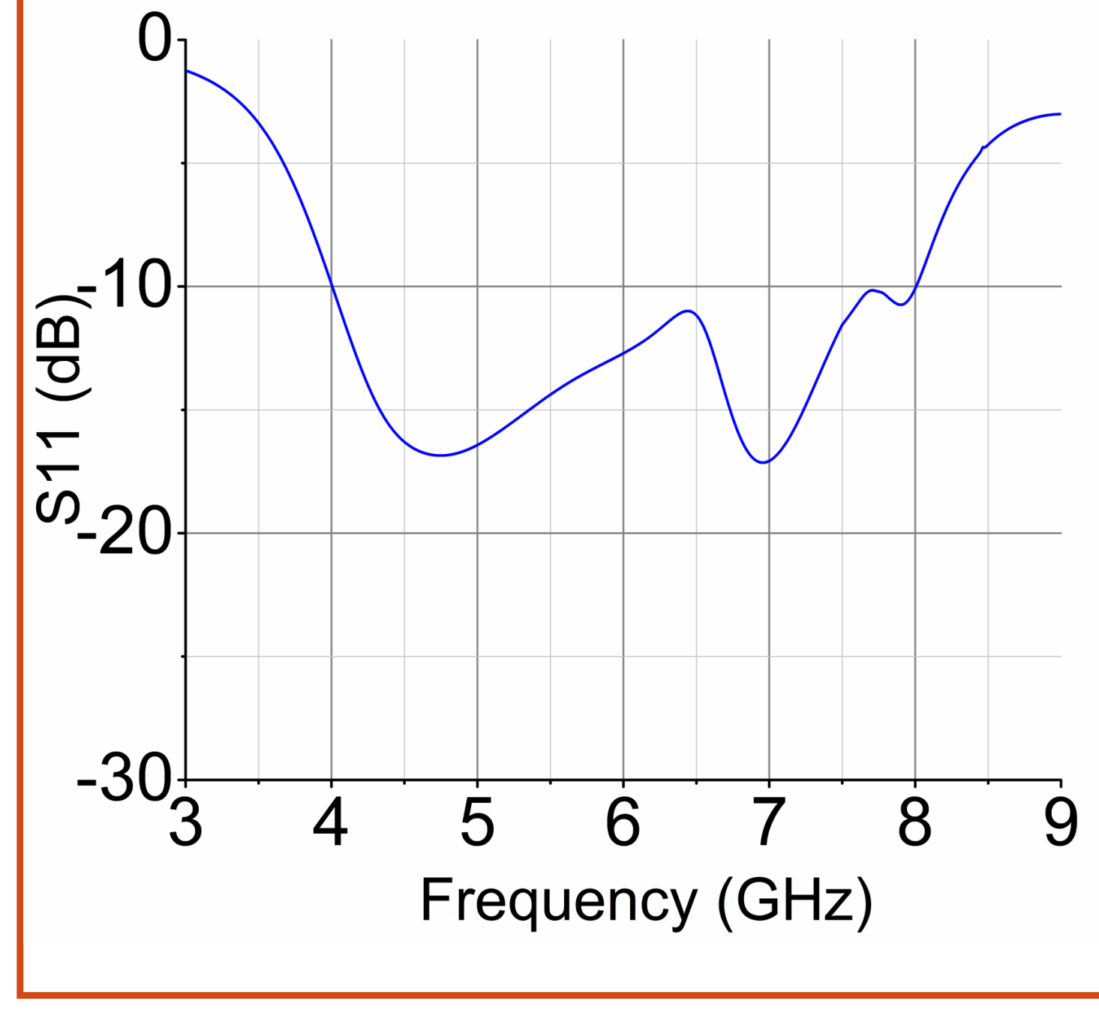
- Fractal shapes can also be incorporated into the single slot-ring antenna to significantly increase bandwidth at both operating frequency bands
- Good radiation parameters over bandwidth are obtained for both operating modes

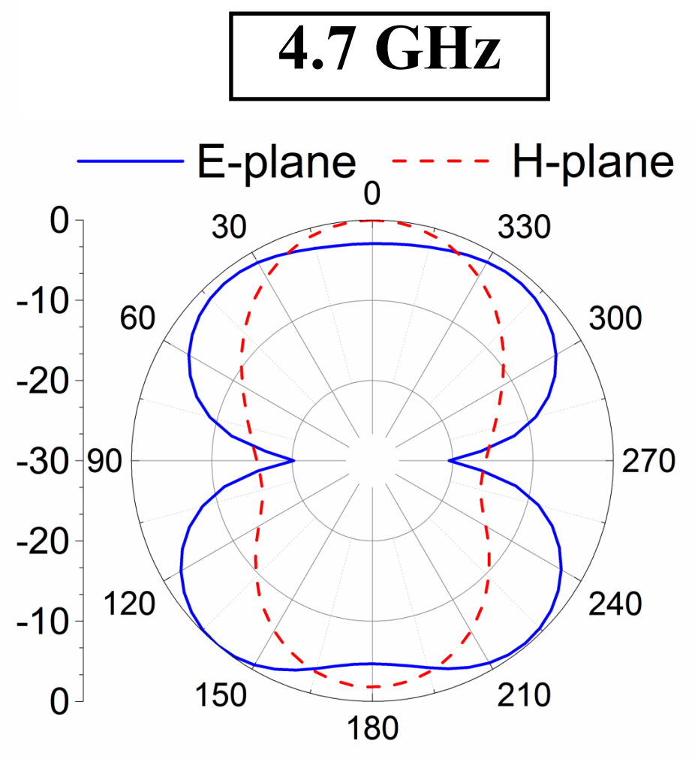






2.8 GHz





4.7 GHz

Conclusion and References

- The proposed antenna is reconfigurable over several specifications such as frequency, polarization, and power level. Frequency reconfigurability has been studied in this paper
- 32 PIN diode switches (DSM8100) are used in the antenna structure to switch between two frequency bands and a balanced double stub loaded microstrip line feeds two concentric slot-rings that operate at lower band
- The gain and FBW of the double slot-ring antenna are improved from a single slot-ring antenna. Furthermore, at higher band, the antenna performance is not compromised.

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